

Learning as an Objective within a Structured Risk Management Decision Process

TIMOTHY L. MCDANIELS*[†] AND
ROBIN GREGORY[‡]

*Institute for Resources and Environment, School of
Community and Regional Planning, University of British
Columbia, Room 415, 6333 Memorial Road, Vancouver,
British Columbia, Canada, V6T 1Z2, and Decision Research
1201 Oak St. Eugene, Oregon 97401*

Social learning through adaptive management holds the promise of providing the basis for better risk management over time. Yet the experience with fostering social learning through adaptive management initiatives has been mixed and would benefit from practical guidance for better implementation. This paper outlines a straightforward heuristic for fostering improved risk management decisions: specifying *learning* for current and future decisions as one of several explicit objectives for the decision at hand, drawing on notions of applied decision analysis. In keeping with recent guidance from two important U.S. advisory commissions, the paper first outlines a view of risk management as a policy-analytic decision process involving stakeholders. Then it develops the concept of the *value of learning*, which broadens the more familiar notion of the *value of information*. After that, the concepts and steps needed to treat learning as an explicit objective in a policy decision are reviewed. The next section outlines the advantages of viewing learning as an objective, including potential benefits from the viewpoint of stakeholders, the institutions involved, and for the decision process itself. A case-study example concerning water use for fisheries and hydroelectric power in British Columbia, Canada is presented to illustrate the development of learning as an objective in an applied risk-management context.

1. Introduction

Managing environment, health, and safety risks has grown steadily more problematic. In many cases uncertainties have broadened, concerns have become more polarized, and regulatory processes have come under greater scrutiny. For virtually every risk issue in North America and Europe, the role of citizens in regulatory and decision processes has grown stronger and placed greater demands on technical specialists and regulatory bodies (1, 2). At the same time, there are increasing concerns about the effectiveness of regulatory actions (3) and the success of processes for involving citizens in these complex choices (4).

Social learning is defined as building knowledge within groups, organizations, or societies. Recently, the term has been used in reference to learning about the relationships among human, technological, and natural systems (5). Social learning could help provide the knowledge and experience for more effective societal risk management approaches. Unfortunately, the experience to date in actively fostering social learning (even within single organizations) has been mixed or even discouraging (6–8). This experience suggests that encouraging social learning will not be easy, particularly in the context of broad-based initiatives involving diverse stakeholders in managing uncertain environmental risks.

Learning through adaptive management (AM) has been widely discussed as a science-based approach to gathering new information about uncertain variables within complex ecological systems. AM proceeds from the premise that policies can be treated as experiments. It involves trying different policy actions in informative contexts, creating experimental designs with controls where possible, avoiding costly failures, monitoring and evaluating outcomes, and selecting a basis for judging what has been learned (9, 10). AM has become an important theme for guiding large-scale environmental research and management projects, involving many organizations and multiple stakeholders (5, 11). Recent examples include studies of Glen Canyon Dam and the Colorado River ecosystem (12), the Missouri River ecosystem recovery (13), and adaptive site management for hazardous waste cleanup (14).

Kai Lee (11) recognized that AM is not pursued by idealized, rational actors, but by interplay among organizations that function on the basis of established rules and well-defined roles, typically within complex political processes. It is designed by individuals in those organizations who operate under cognitive and behavioral limitations on rationality. Lee saw negotiation and planning as ways in which “policy-oriented” learning is accomplished in the world of real politics. He also identified the crucial influence of decision process on the nature and success of learning.

Within the considerable writing on AM, issues of how to foster learning within well-structured decision processes involving stakeholders have received relatively little attention. AM has sometimes floundered because of inattention to concepts of good collective decision-making with stakeholders, while stakeholder processes have often neglected the importance of learning and adaptation. This paper attempts to link AM to concepts of structured decision-aiding (15) involving stakeholder groups (16, 17).

One key aspect of decision aiding in this context involves treating learning as one of several explicit objectives for the policy decision at hand, drawing on *value-focused thinking*, a concept from applied decision analysis (18, 19). It places emphasis on creating and implementing alternatives to foster learning for managing environmental risks, particularly within the context of stakeholder advisory groups. The paper identifies some of the advantages of treating learning as an objective within stakeholder decision processes and reports on the experiences with a series of stakeholder-based water management processes.

The next section of this paper outlines the concepts of a structured decision process as policy analysis to help foster learning. Whereas the standard view of learning within decision analysis is through the *value of information*, here we introduce a related but broader concept that we refer to as the *value of learning*. Section 3 outlines the advantages

* Corresponding author phone: (604)822-9288; fax: (604)822-3787; e-mail: timmcd@interchange.ubc.ca.

[†] University of British Columbia.

[‡] Decision Research.

of a structured decision process in which learning is an objective for risk management contexts. It also briefly draws from examples of water use planning with stakeholders in British Columbia to illustrate these points. Finally we consider the value of learning in this example. The emphasis in this paper is on the role of learning as a means to foster good decision processes within stakeholder groups. Another dimension of learning, not addressed here, involves the subsequent process of implementation, including how policy experiments are conducted and monitored.

2. Concepts To Foster Social Learning

This section introduces several concepts important for guiding decision processes to foster social learning. First we consider a structured decision process as a version of policy analysis that is in keeping with recent writing on risk management involving stakeholders (e.g., ref 1). Then we consider a new conceptual basis for defining and evaluating the benefits of learning in decision process, termed the *value of learning*. Finally we discuss what is needed to treat learning as an objective.

2.1. Structured Decision Process as Policy Analysis with Stakeholders. Policy analysis in North America is often seen as equivalent to social benefit/cost analysis as mandated in U.S. federal regulation and executive orders and emphasized in many texts (e.g., ref 20). Yet significant problems arise when using social benefit/cost analysis as the sole basis for environmental policy decisions (21, 22). Much has been written about the difficulties encountered in working with stakeholder groups when environmental values are translated into monetary terms. Other problems arise as part of the attempts to bridge the gap between BCA and the recent interest in approaches that foster public involvement through "analysis and discourse" as a basis for characterizing risk (1, 2). Some versions of citizen involvement see the quest for informed recommendations as constrained by power imbalances and so give substantial power to citizen panels and other *civic society* groups through consensus processes (23). Yet consensus-based processes also have serious conceptual and applied problems when they are used to provide inputs to policy analyses (24).

The approach to policy analysis described in this paper is between the two poles of benefit/cost analysis and consensus processes. It rests on a solid theoretical base in the decision sciences and psychology (a prerequisite for credibility and good practice) and in our experience has worked well as an applied problem-solving tool (a prerequisite for acceptance by a broad coalition of stakeholders). Social learning over time is an important dimension, because of frequent data gaps and the procedural advantages of this approach in working with stakeholders, as outlined in the next section.

The conceptual basis for implementing social learning is decision analysis as applied in the public sector, involving small groups of stakeholders over a sustained period to offer informed recommendations about their views on public policy choices (16). There is a shared emphasis on the role of science and technical information, as provided by technical specialists, and on values and tradeoff judgments, coming from members of a stakeholder advisory group. Together, the technical analysis and discourse provide a basis for recommendations by each participant about which of the technically feasible alternatives they support, recognizing they could support one, or more than one, alternative.

In simplest terms, one could characterize this approach as a series of steps needed to implement problem-solving, decision-making, or planning in any context. Hammond, Keeney, and Raiffa (15) provide a carefully distilled summary of these steps and the concepts and practice associated with them (see Table 1). As in all good policy analysis, these steps

TABLE 1. Questions to Characterize the Steps of a Structured Decision Process^a

- What is the problem or decision you want to address?
- What are the objectives that matter for this decision, from the view of relevant affected parties?
- What are the alternatives that should be considered, and how can we develop more attractive, new alternatives to better achieve the objectives?
- What are the important consequences of the alternatives we are considering, defined on the basis of the objectives?
- What tradeoffs arise in selecting among the alternatives?
- What are the uncertainties regarding the consequences?
- What are our attitudes toward the risks involved?
- What can we learn for linked decisions?

^a Adapted from: Hammond, Keeney, and Raiffa (1999).

should be addressed iteratively, cycling through as initial information leads to clarification that in turn leads to more questions and opportunities for further refinement. It stops when the needs of a requisite decision model are met (25), and further additional effort is not justified by the additional insight or legitimacy that would be gained.

Value-focused thinking is crucial for directly involving stakeholders in structuring a decision process (18). It starts with the recognition that values are the motivation for all decisions. Hence, decision processes should first characterize the values that matter for the choice to be made from the views of a wide range of stakeholders. Values can be expressed as a structured set of objectives and performance measures. Both are important for creating more attractive alternatives, clarifying the information needed for responsible comparisons of alternatives, and serving as the basis for qualitative or quantitative evaluation.

This structured decision process approach does not assume or require full knowledge and formal rationality on the part of the participants. It assumes that the participants are interested enough in the consequences of the decision to think through their objectives and the alternatives as well as they can, given the best available technical information and the help of analysts and facilitation specialists. The approach recognizes the behavioral and organizational limits faced by the participants and attempts to foster better choices within those operational limits. Hence, it is a prescriptive, decision-aiding approach, with an emphasis on a good process to foster problem solving and build trust, legitimacy, and cooperation among participants.

2.2. The Value of Learning. The *value of information* (VOI) is the standard approach to evaluating learning within decision analysis (19). Within VOI analysis, learning (new information) is evidenced through refining the probabilities of consequences for alternatives, within the current decision. Prospective information only has value if it has the potential to change the choice of alternatives within the current decision.

We prefer a broader view. To explain it, we introduce a closely related concept that we refer to as the *value of learning* (VOL). It recognizes that many aspects of a decision can benefit from learning, including a better characterization of the objectives, creating new alternatives (including ways to better implement existing alternatives), or an improved understanding (and new probabilities) about the consequences of, and tradeoffs among, the alternatives. In addition, learning can occur for related decisions outside the current decision context. This learning could be about the process of making decisions, about the substance of a given kind of decision, about joint decision processes with a given party, or many other aspects. Hence, the VOL can be extremely high if it can affect many related decisions that have recurring elements, common features, and high stakes.

Our definition of the VOL recognizes the potential benefits of learning that improve the basis for (and value of) a current decision as well as future linked decisions. In conceptual terms, the VOL in a given decision context is (a) the expected value (or utility) of the preferred alternative in a preferred decision frame (given new learning about objectives, alternatives or consequences), minus (b) the expected value (or utility) of the alternative that was preferred in the starting decision frame before the new learning, plus (c) the same change in value or utility for all related decisions that are influenced by the new learning. A characterization of the value of learning, based on those comparisons, could be made on the basis of the values of a single decision maker. However, a broader view of VOL is adopted here, in keeping with the role of decision analysis as a means to foster insights (rather than a single optimum choice) in multistakeholder contexts. Hence the VOL is somewhat like the value of research and development: it could affect a long series of future decisions, some of which may be related only indirectly to the initial set of concerns. As described in more detail in section 3, this perspective provides a rationale for why adaptive management is potentially valuable and deserves explicit attention as part of risk management decisions and policy analyses.

2.3. Experience with Identifying Learning as an Objective for Analysis. Adaptive management argues that learning should be considered an implicit objective when creating and analyzing environmental policies (10, 11). Yet, to our knowledge, there are few or no examples from the adaptive management literature in which learning is one of several explicitly stated policy objectives for creating, comparing, and evaluating policy alternatives. Keeney (ref 18, p 128) observes that opportunities for learning arise when a decision-maker faces decisions over time that share common features. For example, in a series of negotiations, learning that occurs in early negotiations can be important in later ones. Including an explicit objective and performance measure for learning as part of the negotiation may affect the negotiation strategy, in that bearing "costs" (suffering a loss on other objectives) may be worthwhile if it provides information that leads to better consequences in future negotiations. Such efforts are one way to link a series of decisions together without building a complex decision model involving many subsequent decisions. In these decision contexts, learning is important enough to be treated as a fundamental objective, even though it is effectively a means to better long-term performance on other objectives.

McDaniels (26) provides an example in which learning is explicitly considered as an objective within a multiple objective decision analysis for a salmon fishery management decision. The decision to be made concerned when to open a salmon fishery, given that two intermixed salmon "stocks" were returning at the same time, and one was much more abundant than expected, while the second was much less abundant. This example shows the three steps needed to treat learning as one of a set of multiple objectives in analytical terms:

- *An Objective.* The need for learning to help address future decisions must be recognized as a fundamental reason for interest in the current decision. Hence, learning should be stated as one of several fundamental ends important in the decision context. A value tree, or objective hierarchy, is a useful way to express the relationships among these objectives (Keeney, 1992). In the salmon fisheries management example, one of the four fundamental objectives for the management decision was to "foster learning" about the biology and dynamics of the salmon stocks.

- *A Performance Measure.* A specific performance measure (or attribute) for the learning objective must be developed. In the salmon fisheries example, the performance measure was a constructed scale representing the number of op-

portunities created for experimental learning about the salmon stocks in the form of significant large scale management experiments.

- *Explicit Tradeoffs.* The willingness to accept reduced performance on other objectives in order to achieve more learning must be considered. Note that these kinds of tradeoffs could be considered in qualitative or quantitative terms. In this fisheries example, managers stated they were willing to bear costs of up to \$1 million in reduced short-term economic benefits from the fishery in order to create an opportunity for learning through a significant management experiment.

Note that, in this decision context, learning is in fact a means for achieving better long-term performance on other fundamental objectives such as economic benefits or fish stock health. Yet, it is legitimate and highly useful to also view learning as a fundamental objective in the current decision, given its scientific uncertainties. Similar reasoning is relevant for virtually all kinds of environmental risk management decisions.

3. Advantages of Learning as an Objective

3.1. Barriers to and Benefits of Good Decision Process.

Making good decisions about learning for risk management starts with a good decision process generally. Over the last half-century, researchers and applied experience have shown that making good risk-management decisions is not easy. Substantial constraints limiting the quality of decision-making processes arise in individuals (e.g., ref 27), small groups (e.g., ref 8), and organizations (e.g., ref 28) for decisions of all kinds. Decisions that create opportunities to learn, for both current and future decisions, are likely to be particularly problematic, because typically they are more complex.

Use of a structured decision process helps shape the basis for a decision. It enriches the set of objectives, clarifies how they are measured, leads to creation of more attractive alternatives, and focuses attention on the nature and quality of technical information regarding consequences. These steps in turn lead to more informed consideration of the tradeoffs arising in selecting among the alternatives. Using this approach helps frame individual and collective thinking and inform the limited rationality that influences all decision processes (15).

The barriers to good decisions, and to encouraging learning as part of those decisions, may be most acute at the level of multistakeholder processes for environmental risk management questions. In these contexts, individual, small group, and organizational barriers all come into play, within an informal organizational context that is not well defined in terms of how to proceed and that may involve substantial conflicts. Community-based multistakeholder initiatives, such as the National Estuary Program in the U.S. (17) or the Water Use Plan process in Canada (16, 24), often have built-in impediments to learning in that each consultative table is encouraged to view itself as an island, with few links to the ongoing consultations in other communities. As a result, each table may view benefits of learning that do not directly help themselves as low, even though from a system-wide perspective the benefits would be high.

3.2. Advantages of Treating Learning as an Objective.

When a structured decision process is employed with a stakeholder group, it is relatively easy to include learning as one of the explicit objectives for the decision at hand. Required steps are (i) agreement that learning matters enough to be viewed as a fundamental end for this decision and (ii) identifying a performance measure for learning in this decision context. Then the learning objective can have substantial benefits, as summarized in Table 2. Here we outline several potential benefits from the viewpoint of

TABLE 2. Advantages of Treating Learning as an Explicit Objective within a SDP for Risk Management Decisions

Stakeholder Advantages
• explicit attention to “What Matters” from different viewpoints
• acknowledgment that information base is limited and uncertain and could be improved
• provides a “Way Forward” for difficult one-time choices with limited information
Organizational Advantages
• helps create an organizational routine and measurable outcome for learning
• fosters creation of a learning plan
• facilitates double loop learning
Decision Process Advantages
• converts one-time decisions to repeated decisions with opportunities for learning and adjustment
• fosters creation of a performance measure for learning
• fosters creation of alternatives to achieve learning objective
• fosters explicit consideration of tradeoffs between learning and other objectives

stakeholders, organizations, and the overall process. These points are illustrated in the next section through a case study.

Stakeholder Benefits. In our experience, stakeholders appreciate the attention to “what matters” from different viewpoints and are encouraged by efforts to create meaningful objectives and performance measures. The learning objective is welcome (even though it does not typically arise directly in suggestions from stakeholders) because it emphasizes the importance of gathering more information and building insight over time in complex and weighty decisions. Stating learning as an objective acknowledges that the current information base and decision frame are limited, which helps build trust in the process among stakeholders.

By far the most important advantage for stakeholders arises in how the decision process is altered. Participants in stakeholder processes for managing environmental risks often feel uneasy when asked to make decisions with uncertain information because they view themselves as stewards of the public trust. If something goes wrong—if a decision has unforeseen adverse consequences in the future—then present-day stakeholders may, at least in part, be held responsible. The learning objective provides a “way out” when faced with limited information and unfamiliar tradeoffs. The prospect of adopting a policy for a period of time and then revisiting that decision when more is learned and the tradeoffs are better understood is attractive to many participants because it changes one-time decisions into iterative, sequential decisions.

Organizational Benefits. There are substantial advantages for organizations involved with the stakeholder process, regardless of their role. Stating learning as an objective helps create an organizational routine to foster learning for the stakeholder process and thus indirectly for the organizations involved. It also creates a performance measure oriented to learning, which leads to monitoring, feedback, and reinforcement. In essence, stating learning as an objective and then monitoring progress based on explicit performance measures is a step toward reflective learning about how to learn better, or “double loop” learning, within an organization (29).

Decision Process Benefits. Finally, stating learning as an objective has substantial advantages for the stakeholder-based decision process. This step leads to an explicit discussion of what kind of learning is needed and how progress will be measured, as a basis for developing a performance measure. An explicit learning objective can lead to creating new, more attractive alternatives that can achieve learning as well as other objectives. It can lead to explicit consideration of tradeoffs among learning and the other objectives, and so provide a more informed basis for choices. It turns one-time decisions into repeated decisions in which there are opportunities for refinement, instead of picking from among the initial alternatives.

Even more significant is that stating learning as an objective can sometimes lead to creation of new institutional mechanisms to foster AM efforts (11). Such mechanisms can be charged with designing, implementing, and monitoring experiments in a science-based, active AM (5, 10). Developing a “learning plan” to guide the activities of this institutional mechanism is a useful and underappreciated step in fostering adaptive management efforts (30).

Kai Lee (11) presents a careful summary of institutional conditions that could create opportunities and barriers for AM (p 85, Table B-5). Table 3 draws on Lee’s useful summary of these issues and suggests how treating learning as an explicit objective can help encourage the opportunities and overcome the barriers to AM.

Of course, learning also involves costs: personnel, money, time, and materials will be devoted to learning, and these resources could be used in other ways. If learning is introduced frivolously or unnecessarily, it could retard acceptance of an appropriate alternative or reduce the resources available for its implementation. Although these concerns have not arisen in projects with which we are familiar, they warrant careful thought. Thus, while we do not believe that treating learning as an explicit objective is a panacea for all institutional barriers, we believe it can help strengthen the commitment to improved risk management

TABLE 3. Institutional Conditions Affecting Adaptive Management and the Influences of Treating Learning as an Explicit Policy Objective^a

enabling conditions	obstacles	influence of learning as an explicit policy objective
There is a mandate for action in face of uncertainty.	Experimentation can conflict with other primary management objectives.	The tradeoffs between learning and other objectives are made explicit. The reasons for attention to learning are made clear.
Decision makers are aware they are experimenting anyway.	Experimentation is an admission there may be no positive return; stating hypotheses raises the risk of potential failures.	The institutional commitment to experimentation is legitimized.
Preservation of pristine environments is no longer an option.	Remedial action requires coordinated implementation over long time frames.	Coordinated action starts with agreement on objectives.
Resources are sufficient to measure ecosystem scale behavior.	Data collection and institutional commitment are subject to disruptions in budget or leadership.	Explicit attention to objectives as endorsed by all interested parties can help the program weather changes.

^a Source: Adapted from: Lee, 1993, Table B-5 p 85.

TABLE 4. Implications of Treating Learning as an Objective for the Alouette River Management Committee

Stakeholder Implications

- facilitated the discussion of values as a basis for defining specific objectives and performance measures to guide the plan
- eased worries about being asked to make permanent decisions concerning water flows when implications were unclear
- lowered potential responsibility costs through a solution that allows for revisiting decisions

Organizational Implications

- fostered creation of a management committee as a new institutional mechanism to supervise experiments regarding water flows and fish
- helped make learning as an objective more routine for other water use planning efforts
- created attention to double loop learning (learning for better learning)

Decision Process Implications

- provided opportunities to refine Alouette River Water Management over time
- encouraged the consideration of tradeoffs between water flows and power outputs through experimental trials
- created performance measures to evaluate learning that have influenced consultation at other facilities
- led to creation of an alternative that resulted in a consensus agreement that was immediately implemented and is widely seen as a major improvement

by the participating organizations.

3.3. Drawing on Experience with the Alouette River Management Committee. This discussion of the potential benefits of treating learning as an objective in stakeholder processes draws heavily on our experience with the Alouette River Management Committee. In 1995, we were asked to help guide this multistakeholder process to develop a new operating plan for water flows at hydroelectric power facilities near Vancouver, British Columbia. Tradeoffs among power generation, fisheries habitat, and flood control were crucial, and the utility faced major regulatory concerns about relicensing its facilities, due to adverse effects on fish habitat and occasional flooding.

We met over a 6-month period with a representative stakeholder group that included a wide range of participants from the local community as well as local government, provincial, and federal resource management agencies, the local utility (British Columbia Hydro), and First Nations. The primary goal was to meet the directive of the regulatory authority (the provincial Water Comptroller) to consult with these groups and recommend a new water management plan for the South Alouette River. The activities of the committee and content of the stakeholder meetings were focused on addressing the steps summarized in Table 1 and refining both the framework and information base for the decision. Hence the Alouette River Management Committee (ARMC) process was conducted as a structured decision process. More detail regarding the ARMC process, how it was conducted, and its results can be found in refs 16 and 24. Further discussion is presented in the Supporting Information. It addresses in detail how treating learning as an explicit objective influenced the Alouette River multistakeholder process. Table 4 briefly summarizes the major implications. It indicates that the discussion in section 3.2 about the benefits of treating learning as an objective within multistakeholder decision processes closely reflects our experience with the Alouette River Management Committee. It briefly summarizes the implications of this approach for the participants, the organizations, and the decision process itself.

We are convinced that treating learning as an explicit objective was a major reason the process was successful.

The successes can be judged in comparison to the situation before the Alouette River Management Committee, which involved major conflicts among stakeholders, regulators, and the utility and which would likely have continued. The process achieved a consensus decision in what was a hostile environment as well as several other direct benefits outlined below.

3.4. The Value of Learning in the Alouette River Management Committee Context. The value of learning can be characterized as the value of the alternative selected in the final decision frame (i.e. the final answers to the questions in Table 1) compared to the preferred alternative in the starting decision frame (i.e. the initial answers to the questions in Table 1). We can use the Alouette River example to illustrate the concepts introduced in section 2.2. As a starting point, note that a standard VOI analysis could not have been conducted in this context, because no decision analytic framework with value complete functions had been developed, and no probabilities were updated. Yet the value of learning, as defined earlier, was substantial, both for the immediate decision context and for future decisions.

Immediate Decision Context. For these purposes, we can view the starting decision frame as being how BC Hydro viewed the question of the best operating rules for water management on the Alouette River, before the Alouette River stakeholder process. Through the decision process, more stakeholders became involved in the decision, new objectives were identified, new alternatives were created, more was learned about the impacts and uncertainties, understanding and perspectives were shared, and a consensus decision was reached.

The final decision frames and selected alternatives included the following aspects: (i) a new operation strategy for flood control purposes that achieved substantial improvements in flood control at little reduction in the value of power produced, (ii) new low-cost strategies for improving fish habitat, and (iii) an institutional mechanism to foster more experimentation and learning over time with a smaller group. In addition, an ongoing conflict and litigation was resolved, and the electric utility achieved some regulatory security by completing relicensing for the facility. While no formal analysis of the value of learning was conducted, it was clearly substantial from the views of all interested parties.

Related Decision Contexts. The results of the Alouette River process encouraged BC Hydro and provincial regulatory agencies to expand the consultative water-use planning process to all other major hydroelectric sites in the province. The first step was to develop a set of guidelines for the consultative water use planning process, based on the structured decision-aiding process followed at the Alouette River. The guidelines call for creating separate structured decision processes with representative tables of stakeholders for each of the approximately 20 watersheds with facilities in the BC Hydro electrical system (31).

As of spring 2002, nine water use plans have been completed and another 12 or so are underway. Each has followed variants of the decision process summarized in Table 1. In all cases, the pros and cons of adaptive management options were discussed as a response to reducing uncertainty and learning more about the impacts over time of the newly proposed water flows on key objectives, including fisheries, wildlife, flood protection, and the preservation of First Nation cultural sites. In essence, the combination of adaptive management and a structured decision process has led to the creation of double loop learning within each Water Use Plan involving federal, provincial, and local government organizations, community stakeholders, First Nations, and (ultimately) the regulators and decision makers.

These water use plans have tackled and largely resolved some of British Columbia's most important conflicts between

fisheries and power production. In addition, several major flood control and recreation conflicts have been resolved. The total cost to address these issues has amounted to substantially less than \$50 million CDN per year in power cost that provincial officials originally had budgeted as an overall constraint (32).

4. Discussion

Including learning as an explicit objective of risk management policies enables participating stakeholders, institutions, and decision makers to recast difficult policy choices in a way that increases the opportunities for successful deliberation. Learning thus has the potential to play an important role as part of a structured decision process. The key step is to recognize that learning is potentially valuable, for a variety of reasons: scientific uncertainty can be reduced, institutional performance and cooperation can be increased, conflict and the push for litigation can be eased, and the defensibility of the decision process can be enhanced.

The concept of the value of learning thus broadens the more familiar notion of the value of information, which emphasizes reductions in uncertainty. This broader scope of the value of learning captures many of the institutional and process benefits of adaptive management approaches. It also includes the possibility of realizing benefits from other choices, particularly in the context of multisite consultations, or for other time periods, in that it can change a one-time decision into a sequential decision.

Ultimately, the most important benefit of including learning as an objective is that it can enhance the creation of new, more attractive policy alternatives. Nearly as significant is that by including learning over time, participating stakeholders can be helped to feel better about their input to a policy choice that may appear complex and puzzling. As many facilitators and analysts can attest, this advantage, combined with an increased trust in the decision process, can make all the difference between continued conflict and the successful realization of an opportunity for improved risk management policy.

Supporting Information Available

The Alouette River management committee example overview: the water use plan process, Alouette River water-use plan objectives, creating an alternative concerned with learning, results of the Alouette River consultation process, and objectives for ARMC policy recommendations (Table 4). This material is available free of charge via the Internet at <http://pubs.acs.org>.

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Received for review December 13, 2002. Revised manuscript received January 9, 2004. Accepted January 12, 2004.

ES0264246